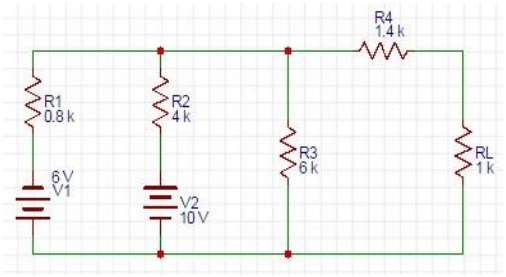
HOME ASSIGNMENT
B. Sc. (H) PHYSICS SEM II

Date of Submission: 24th March, 2017 *Max Marks: 100*

1. Convert the following linear bilateral network into Thevenin's equivalent network and then into Norton's equivalent network. Show that the power delivered to the load in both the case is same. (10)



2. Find the electric field a distance z above the centre of a square loop of each side length (a) carrying uniform line charge density λ. (5)

3. A hollow spherical shell carries charge density $\rho = k/r^2$ in the region $a \leq r \leq b$, where a and b are inner and outer radii respectively. Find the electric field and electric potential in the three regions: (i) $r < a$ (ii) $a \leq r \leq b$ (iii) $r > b$. (10)

4. Which one is an impossible electrostatic field?
   a) $\vec{E} = xy\hat{\imath} + 2yz\hat{\jmath} + 3xz\hat{k}$
   b) $\vec{E} = y^2\hat{\imath} + (2yz + z^2)\hat{\jmath} + 2yz\hat{k}$ (2)

5. The electrostatic potential at a point in a plane is given by
$$V = \frac{a\cos\theta}{r^2} + \frac{b}{r^2}$$
Find the electric field at any point. (3)

6. A spherical liquid drop has a diameter of 2 cm and is given a charge of 1μC.
   a) What is the potential at the surface of the drop?
   b) If two such drops coalesce to from a single drop, what is the potential at the surface of the drop so formed? (5)

7. Show that potential energy of a system of charges can be calculated from the electric field by assigning an amount of energy $(1/2)\varepsilon_0 E^2 d\tau$ to every volume element $d\tau$ and integrating overall space. (5)

8. Derive an expression for electrostatic energy of a uniformly charged sphere and show that it is 6/5 times the energy of a conducting sphere having the same amount of charge and of same radius. (10)

9. Obtain the expression for the potential and the electric field due to a dipole at point P(r, θ). Explain the motion of the dipole when an electric dipole is kept (i) parallel and (ii) perpendicular to a non-uniform electric field. (10)

10. State and Prove the uniqueness theorem. (5)

11. A capacitor has square plates, each of side a, making an angle θ with each other. Show that for small angle θ the capacitance is given by (5)

$$C = \frac{\varepsilon_0 a^2}{d\left(1 - \frac{a\theta}{2d}\right)}$$

12. Explain the 'Method of Images'. A point charge (q) is placed in front of an earthed conducting sphere of radius (a) at a distance (s) from its centre. Determine, using the method of images:
    a) the potential and the field at a point outside the sphere.
    b) the induced charge density on the sphere
    c) force of attraction between point charge and the sphere.

    How are the results affected if the sphere is held at a constant potential V_0 ? (10)

13. What is meant by polarization ? Show that the polarization of a dielectric medium gives rise to a volume density of charge τ_p (given by $\vec{\nabla}.\vec{P}$) and a surface density of charge σ_P (given by $\vec{P}.\hat{n}$). (10)

14. Obtain generalized form of Gauss's law for a polarized dielectric. (5)

15. Define $\vec{E}, \vec{P}$ and $\vec{D}$. Establish the relation between them. (5)